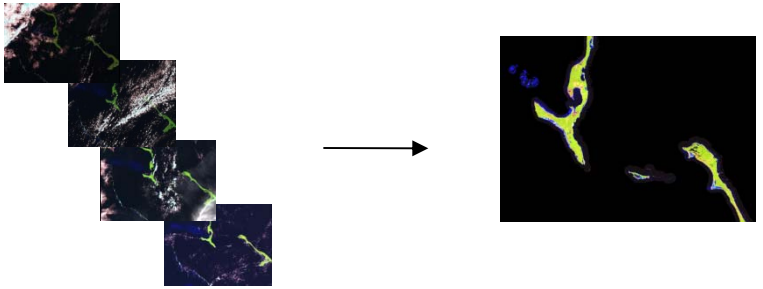


Interpreting image time series in persistently cloudy regions: Substituting time for vertical forest canopy space

Landsat Science Team Meeting
January 19-21, 2010, Mountain View, CA
E.H. Helmer, T.S. Ruzycki, J.M. Wunderle, S. Vogesser,
B. Ruefenacht, C. Kwit, T.J. Brandeis and D.N. Ewert

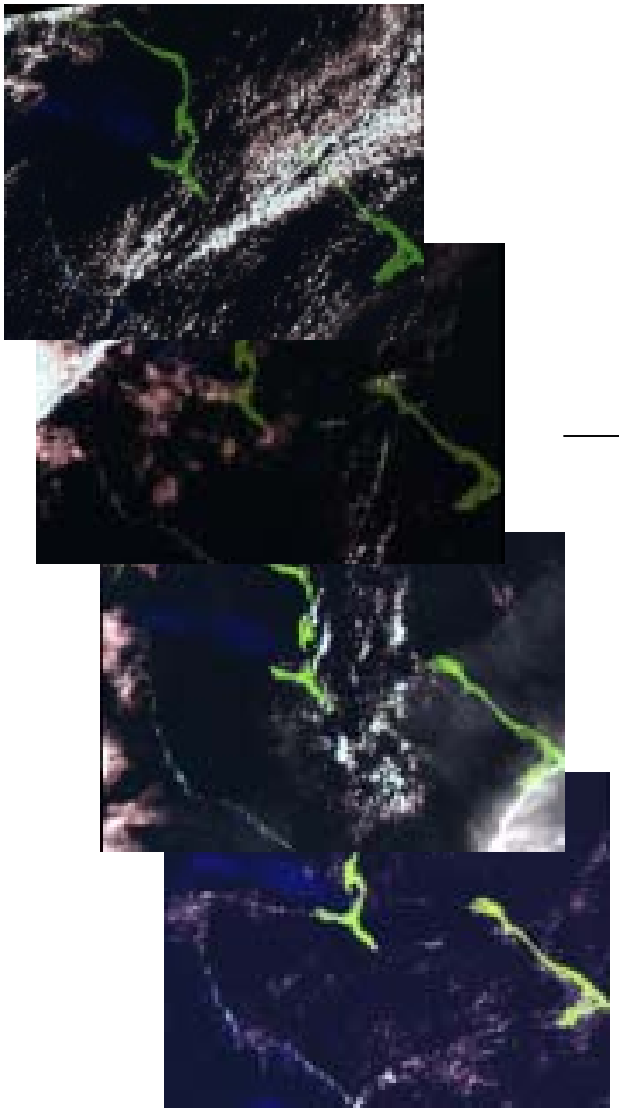
FOREST SERVICE US DEPARTMENT OF AGRICULTURE

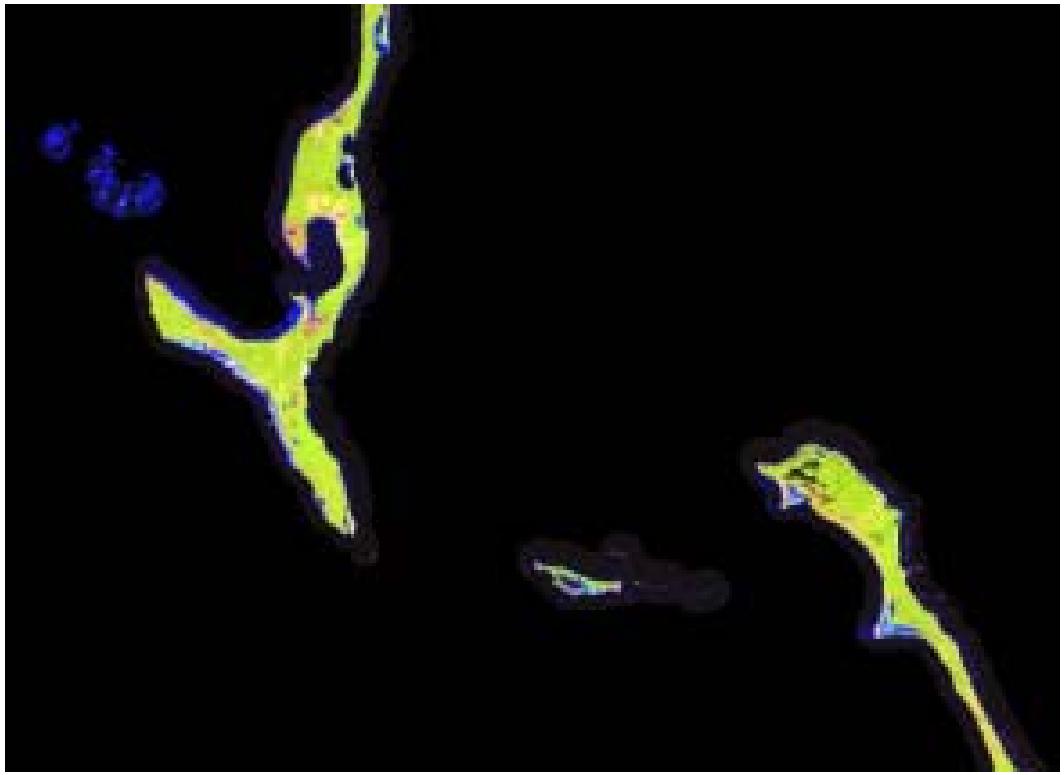
MIAMI UNIVERSITY 1809

INTERNATIONAL INSTITUTE OF TROPICAL FORESTRY

RSAC

Colorado State University
Knowledge to Go Places



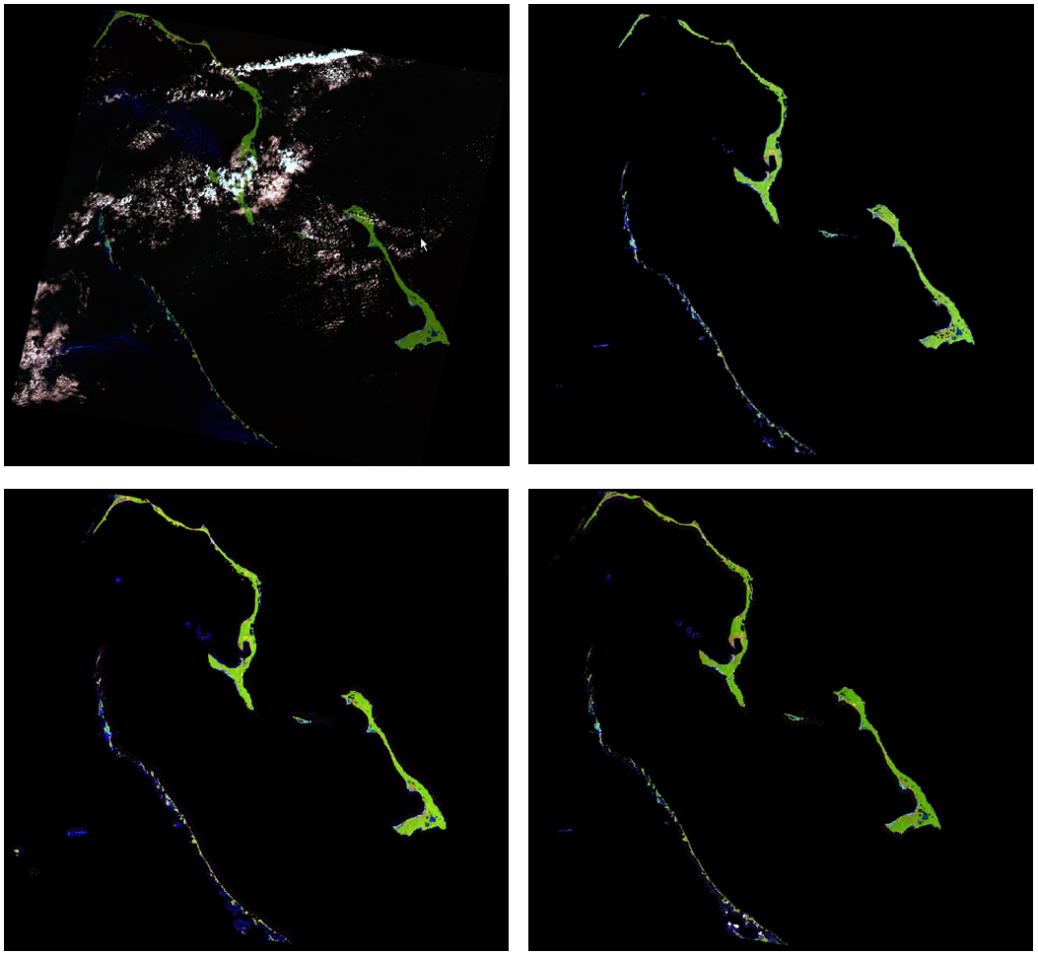


1993-94 cloud-cleared mosaic

What a user gets now

What we could produce

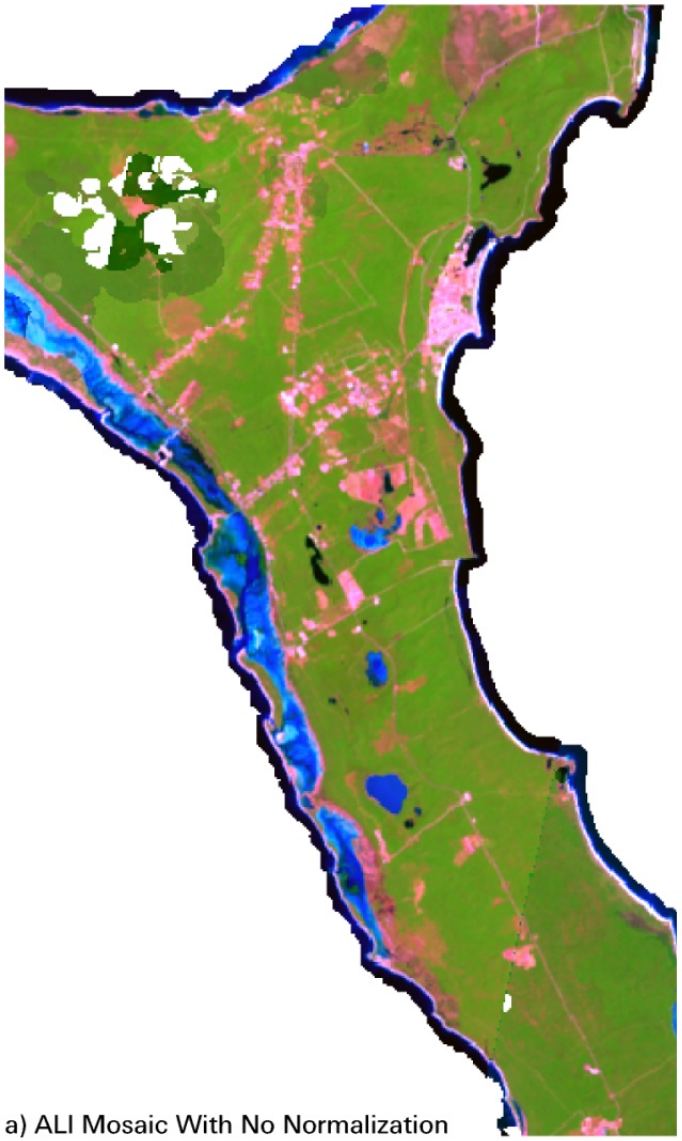
A cloudy scene *vs.* three examples of cloud-cleared mosaics made with the regression tree normalization method of Helmer and Ruefenacht (2005)



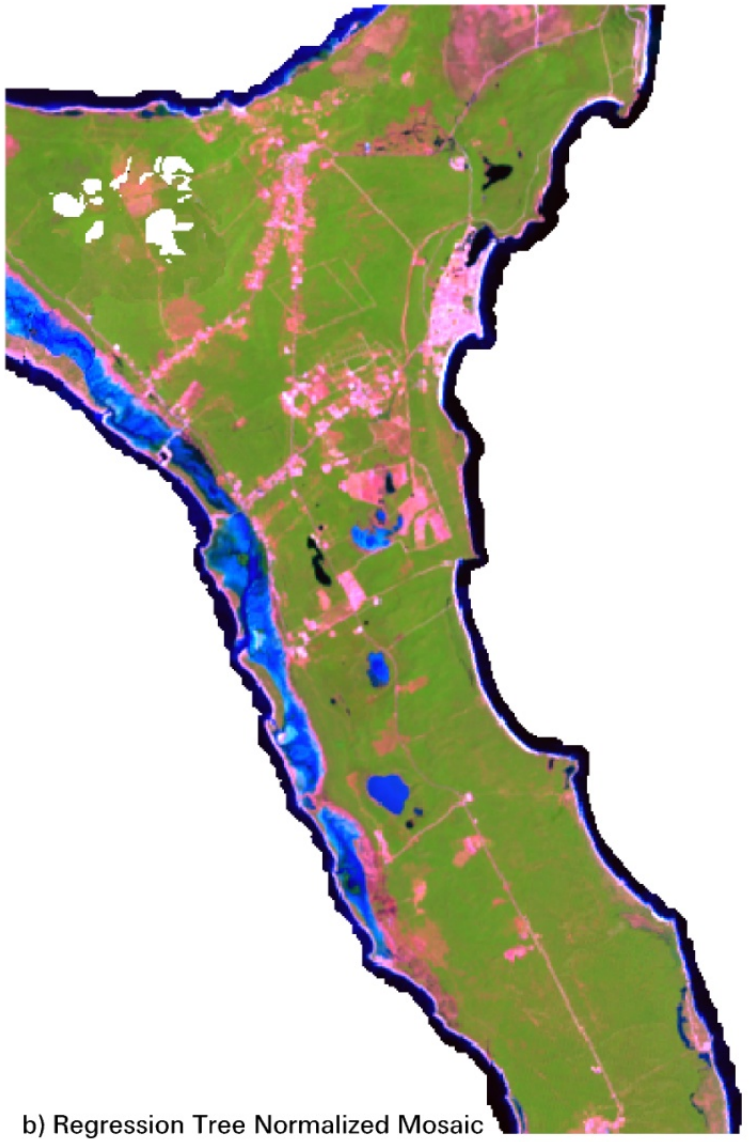
8-step series of cloud-cleared imagery created with regression tree normalization

Base year of time step	Scene dates (month/day/yr) and image type	Cloud cover over study area (%)	Cloud cover in final mosaic (%)	Base year of time step	Scene dates (month/day/yr) and image type	Cloud cover over study area (%)	Cloud cover in final mosaic (%)
1984	06/03/1984 – L5	0.1	0.1	**2000**	03/11/2000 – L5	20	0.0
					02/08/2000 – L5	17	
1988	12/15/1988 – L4	42	3.6		11/28/1999 – L7	22	
	04/03/1988 – L4	16					
1993	11/19/1993 – L5	31	0.1	**2001**	03/06/2001 – L7	15	0.7
	12/05/1993 – L5	29			02/02/2001 – L7	23	
	01/22/1994 – L5	35			11/17/2001 – L7	45	
	02/23/1994 – L5	39					
	03/11/1994 – L5	45		**2002**	11/04/2002 – L7	1.2	0.0
	12/08/1994 – L5	35			01/23/2003 – L7	21	
1996	12/29/1996 – L5	25	0.2	**2005**	04/11/2005 - ALI	23[1]	12[1]
	12/27/1995 – L5	15			05/04/2005 – ALI	42[1]	
	01/28/1996 – L5	17			05/29/2005 – ALI	38	
					01/15/2006 – ALI	56	

Regression tree normalization works well to create virtually seamless cloud-cleared Landsat and ALI image mosaics



a) ALI Mosaic With No Normalization



b) Regression Tree Normalized Mosaic

Which automated methods for mapping forest disturbance or age require seamless cloud-cleared mosaics?

- Seamless mosaics not needed
  - Image clear parts can be classified separately: Helmer *et al.* 2009; Asner *et al.* 2009 (phenology?); Gao *et al.* 2009 (urban)
  - Image mosaic classified with spatially comprehensive training data and machine learning algorithm: Hansen *et al.,* 2008; Gao *et al.* 2009 (urban)
- Seamless mosaics needed?
  - Classify based on trends: Masek *et al.* 2006; Huang *et al.* 2009; Kennedy *et al.* 2007

Tropical dry forests cover a large geographical area

An inhabitant of Neotropical dry forests: a Great Lizard Cuckoo

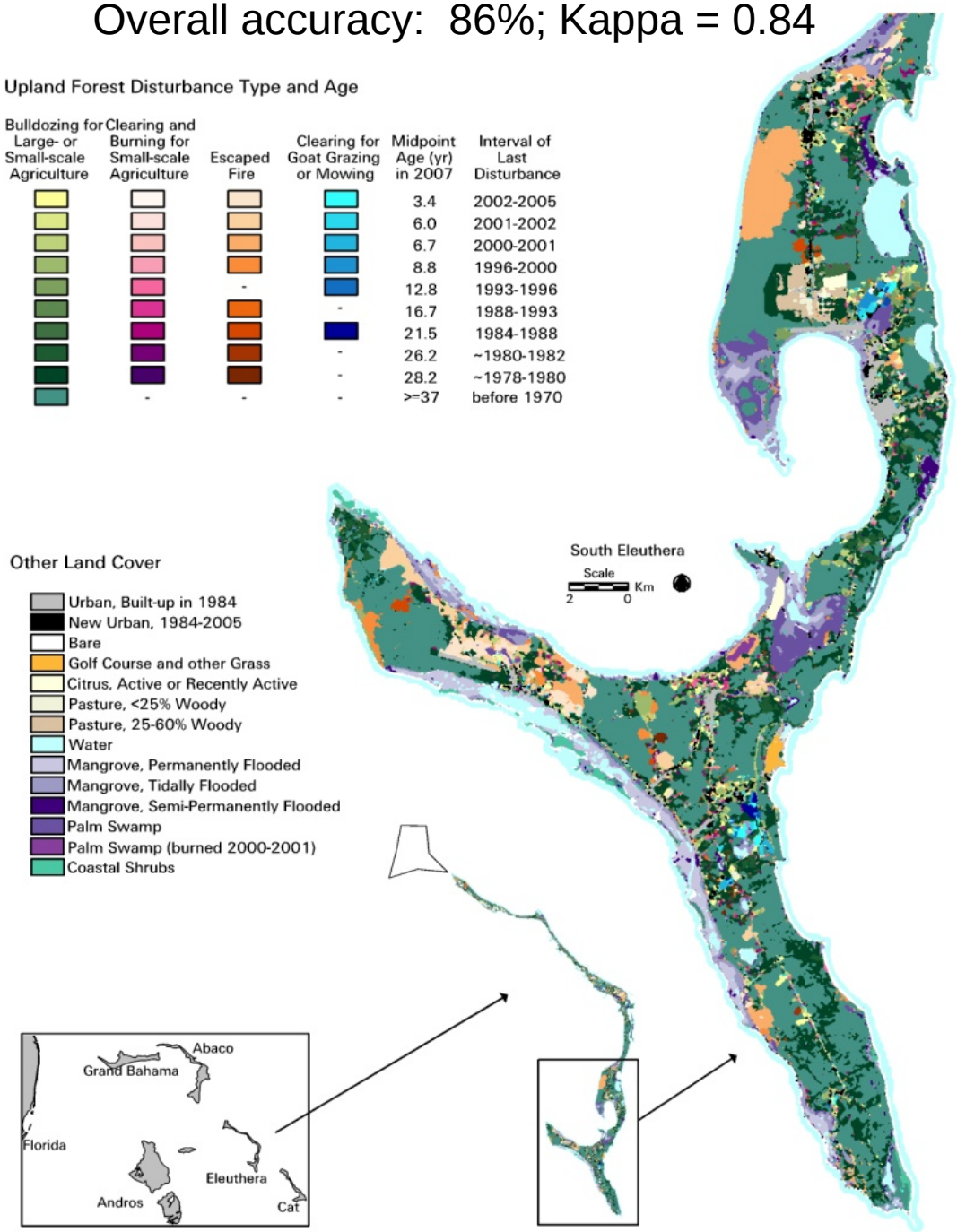
Overall accuracy: 86%; Kappa = 0.84

Forest disturbance type and age can be accurately (and simultaneously) mapped from a time series of cloud-cleared Landsat and ALI images

Dates of base scenes for cloud-cleared mosaics:

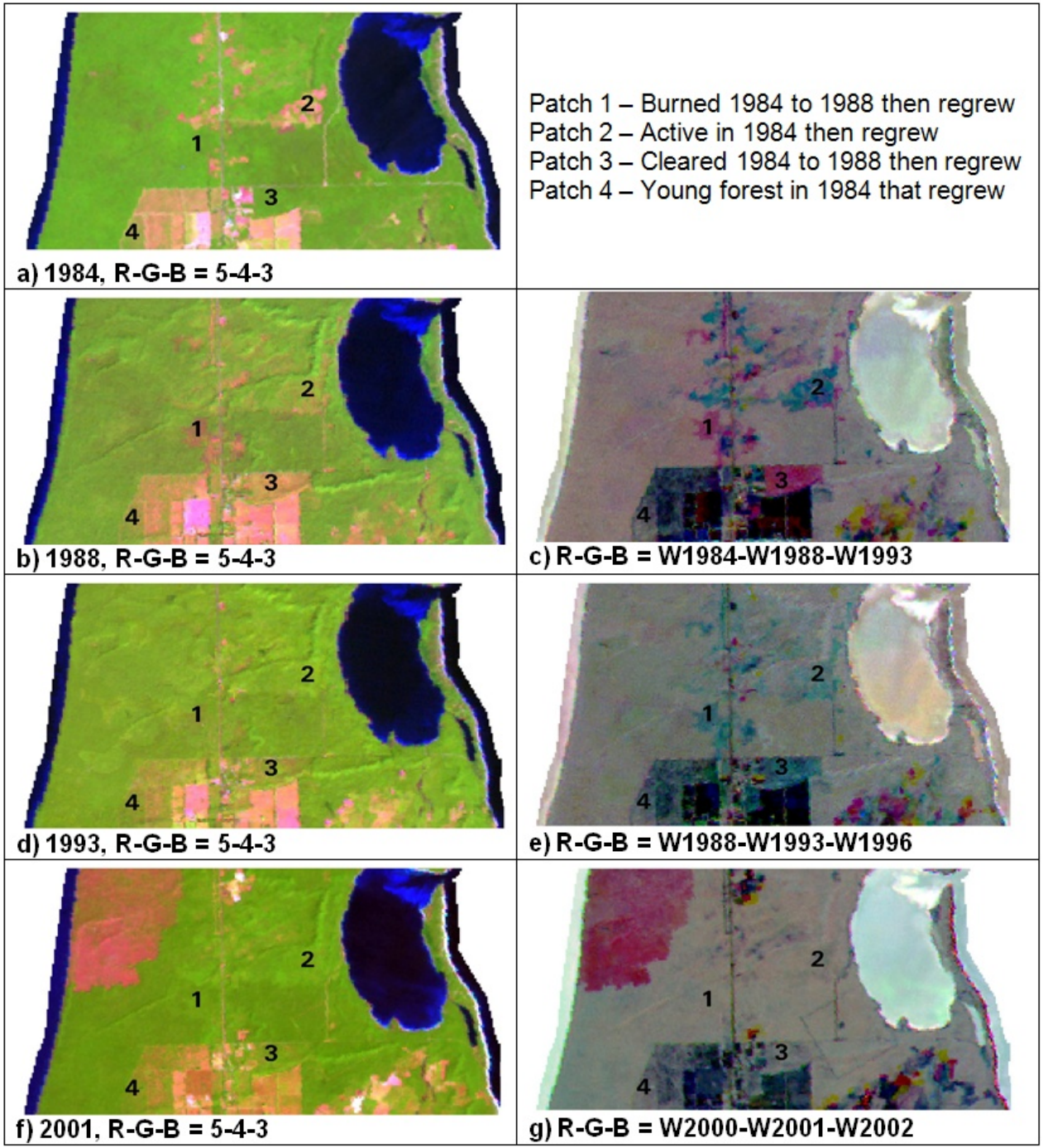
1984, 1988, 1993, 1996, 2000, 2001, 2003, 2005

Helmer *et al.* submitted



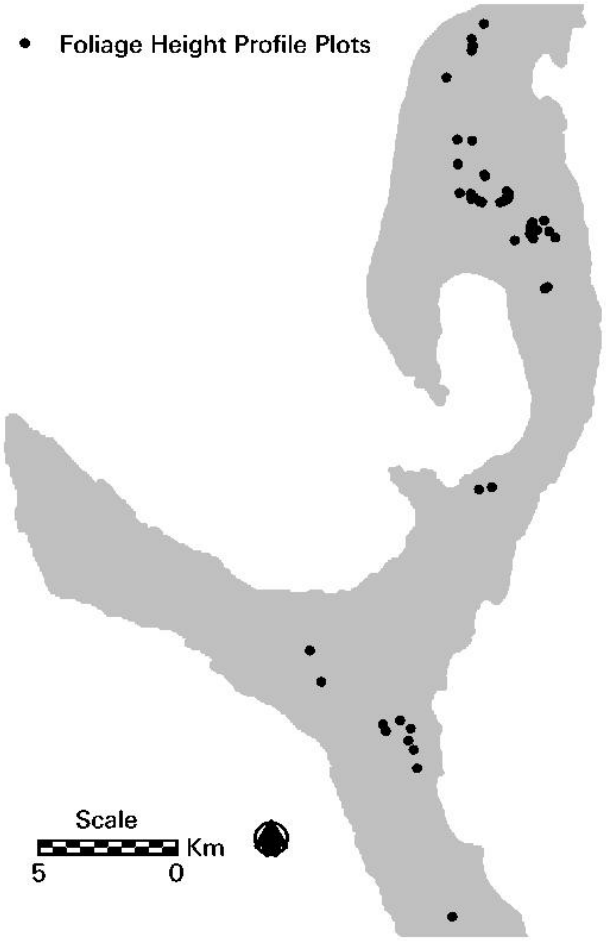
If some automated methods do not require seamless cloud-cleared mosaics, why make them for forest monitoring?

Conuco



Visualize forest change with time series of *RGB-TC wetness composites (Helmer et al. 2009 J. Appl. Rem. Sens.)*

Measured foliage height profiles at 48 plots selected via a random sample of patches stratifed by forest disturbance type and age

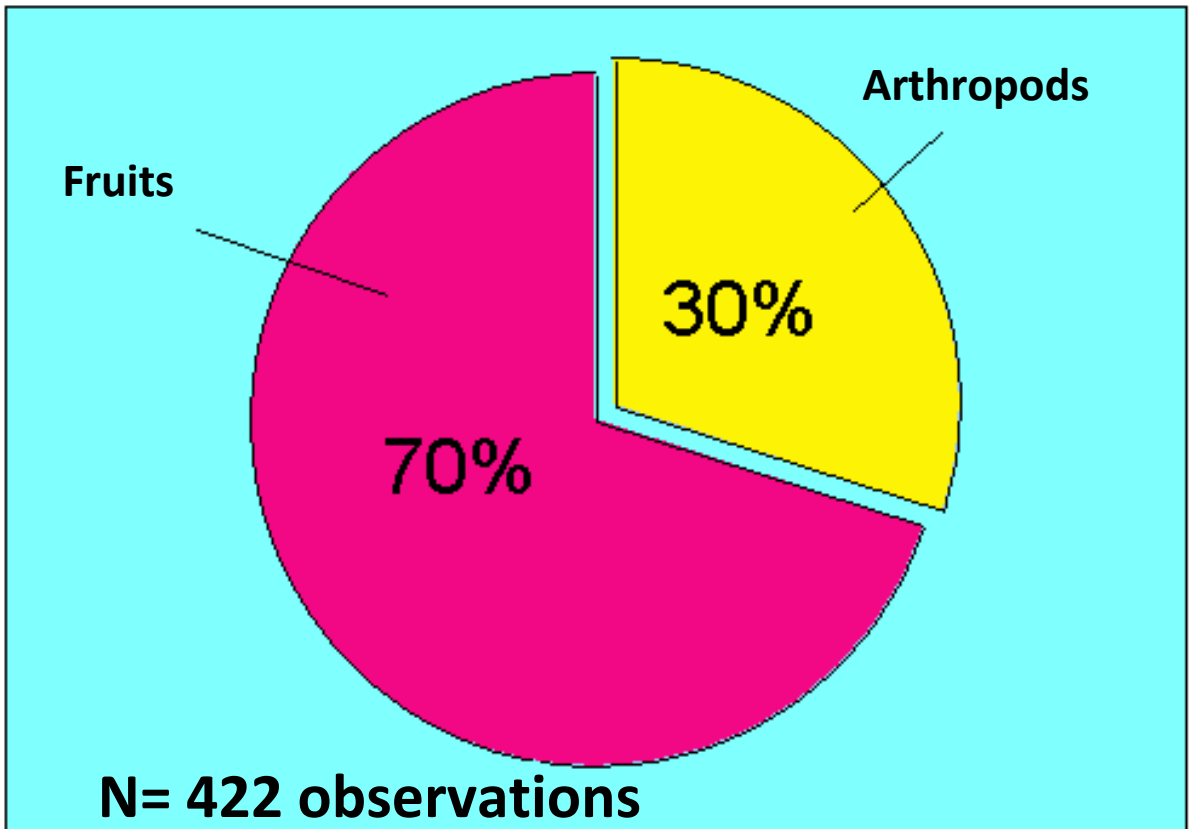


Clustered points tend to be goat-grazed patches of different ages

Certain fruits important to winter diet

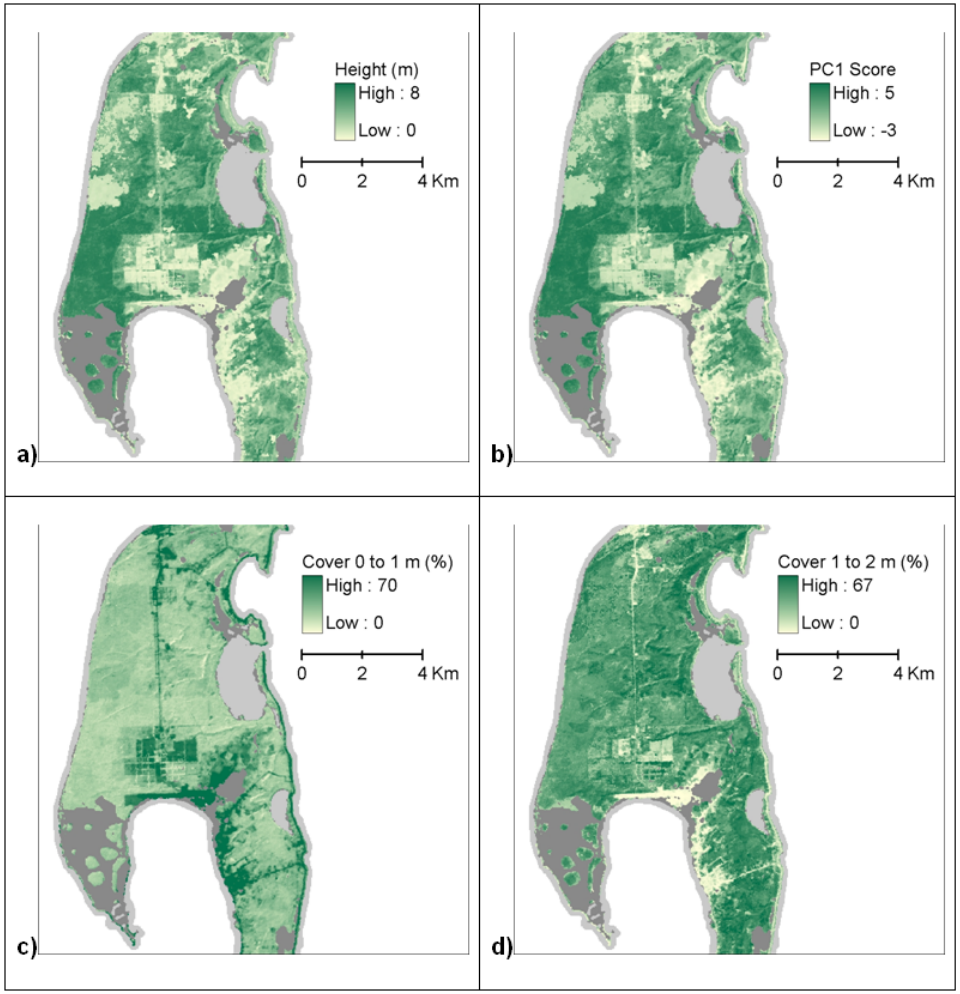
Chiococca alba

Erithalis fruticosa

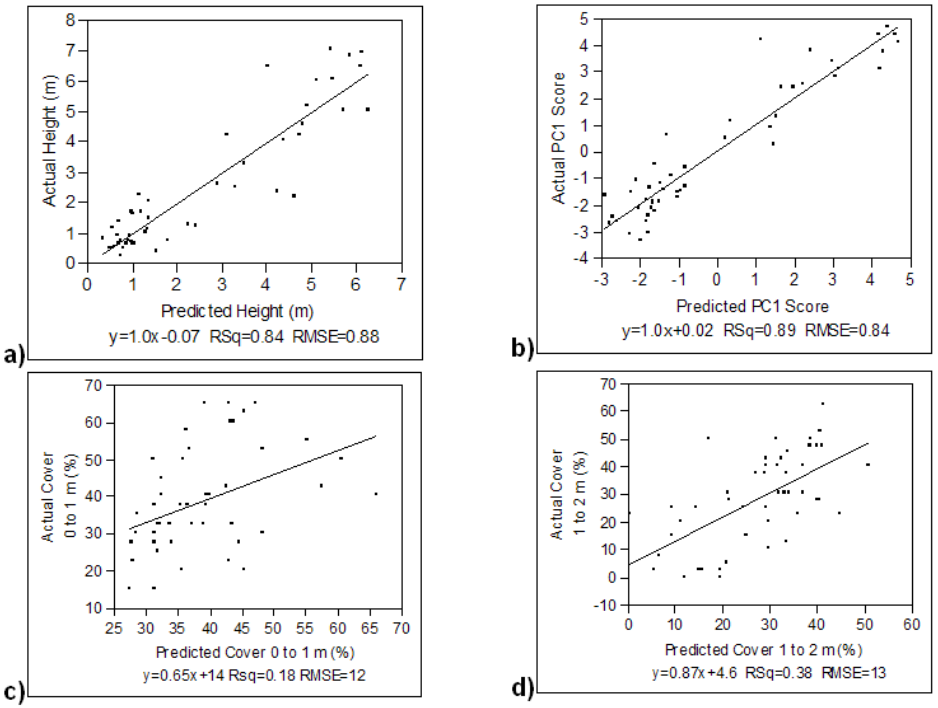


Lantana involucrata; L. bahamensis

Tropical dry forest height and foliage height profiles can be accurately mapped from a time series of cloud-cleared Landsat and ALI images

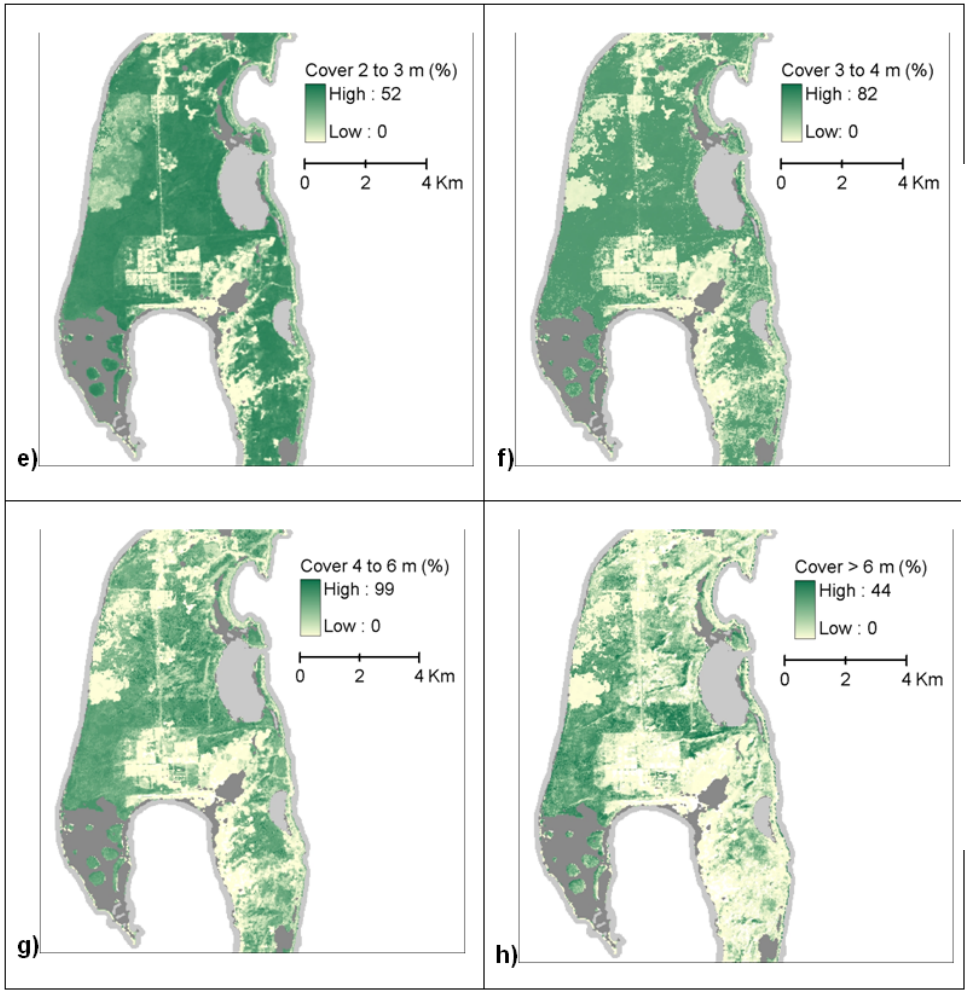


Actual vs. predicted RSsquare from 10-fold cross-validation: 0.18 – 0.89

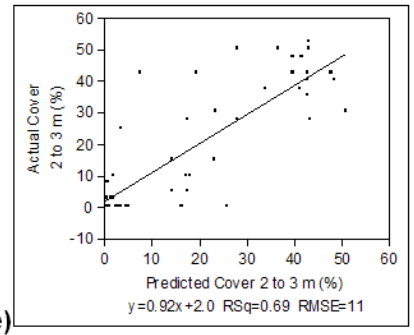


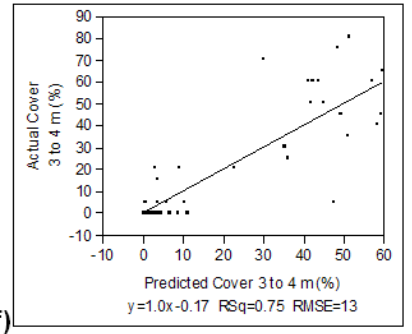
Helmer, Ruzycki, Wunderle *et al.* subm.itted

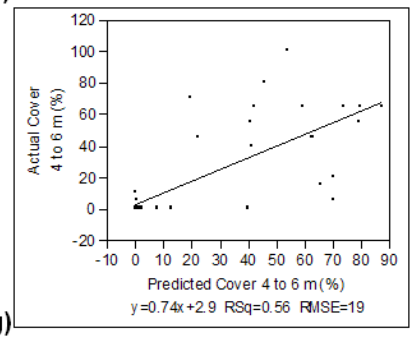
With sparse training data from field plots, cloud-cleared image mosaics must be fairly seamless to avoid map discontinuities

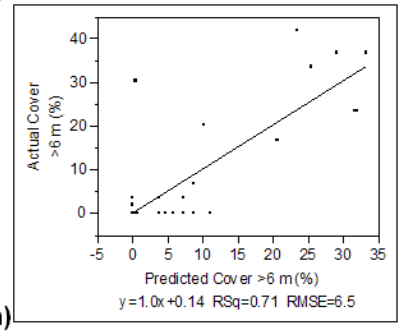


Bias from 10-fold cross-validation: mostly negligible



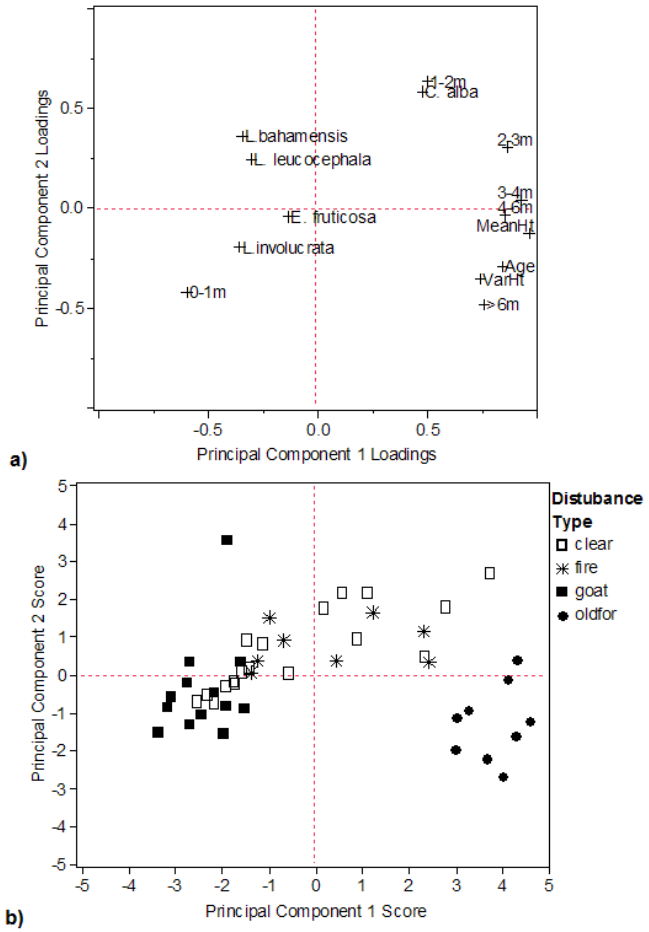




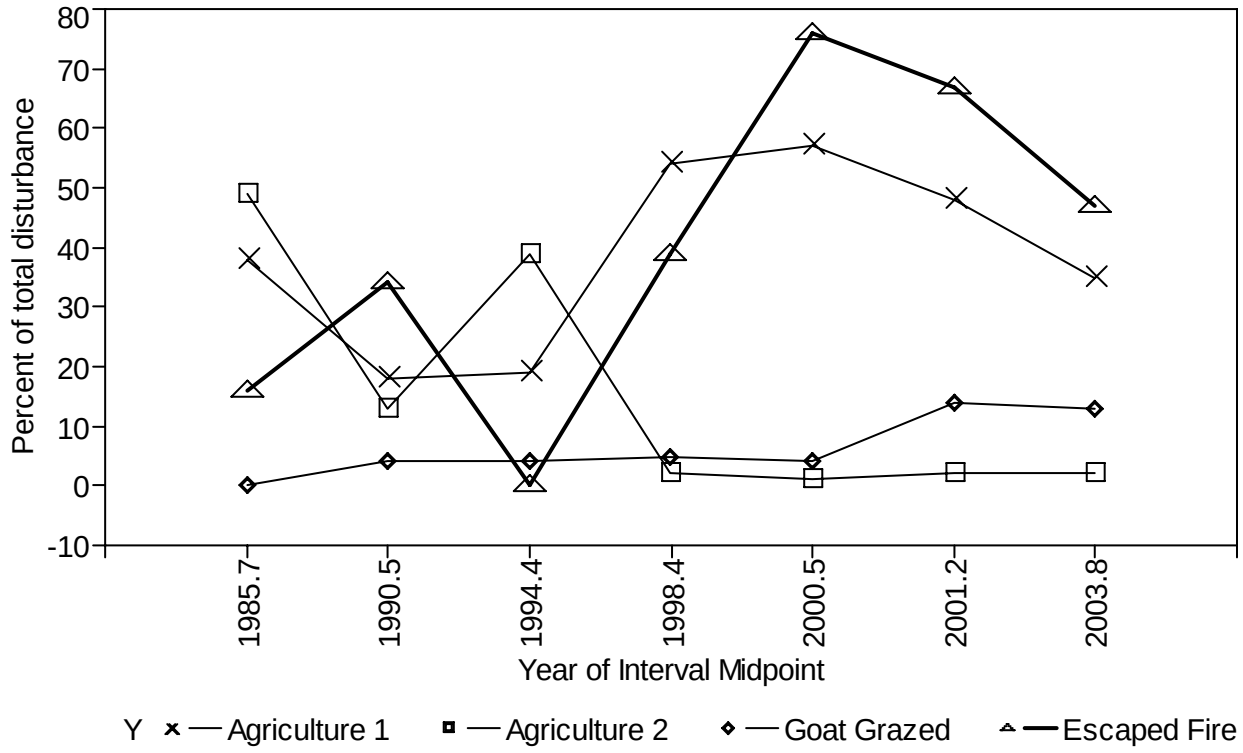


Helmer, Ruzycki, Wunderle *et al.* subm.itted

PCA of foliage height profile data to illustrate relationships between forest structure and disturbance type, age and species composition



Helmer, Ruzycki, Wunderle *et al.* subm.itted



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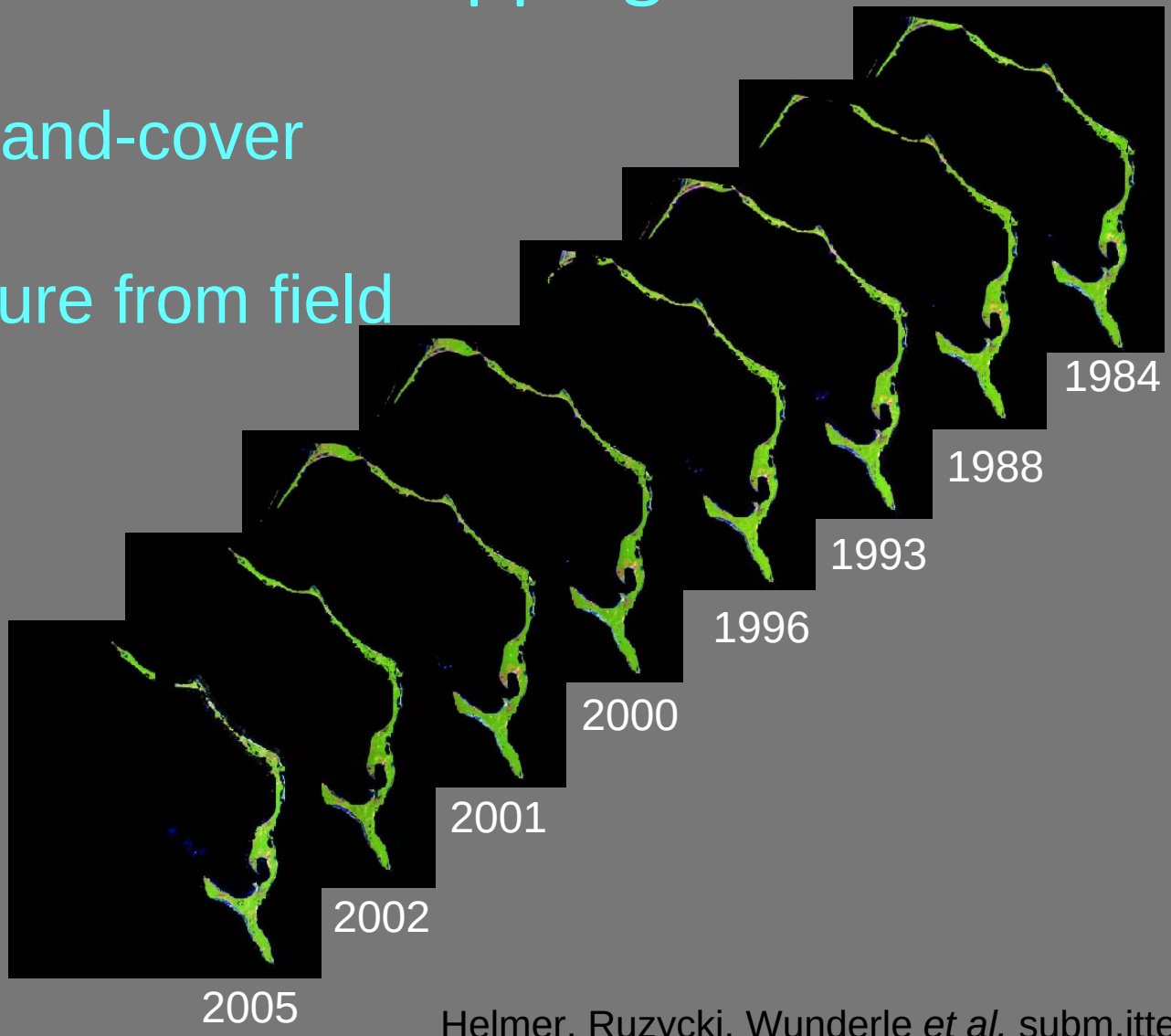
Seamless cloud-cleared image time series are needed for mapping…

1. Specialized land-cover change
2. Forest structure from field plot data



Helmer, Ruzycki, Wunderle *et al.* subm.itted

Conclusions

- Time series of seamless cloud-cleared imagery are needed for
  - Detecting specialized land cover change
  - Mapping based on limited field data, like forest plots
- Such mosaics permit seamless mapping of tropical dry forest three-dimensional structure where forest disturbance type and age are related to forest height
- OLI should enhance our ability to map forest structure
- *RGB-wetness composites* enhance visualization of forest change
- Creating such images for the 28 yr from 1972-1999 requires a method that does not rely on MODIS
- In this study area, regression tree normalization works for ALI data and supported the creation of 7 cloud-cleared images to support the above mapping and visualization

Questions?